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REGULAR ARTICLE

Socio-environmental factors associated with diabetes mellitus among patients hospitalized with schizophrenia in Japan

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Abstract
Objective This study aimed to examine epidemiologically socio-environmental factors associated with diabetes mellitus among patients hospitalized with schizophrenia in Japan.
Methods This was a cross-sectional study from a single psychiatric hospital. Study patients were adults aged ≥20 years who were hospitalized with schizophrenia one or more times between January 2013 and December 2014. From electronic medical records or health insurance claims, we extracted schizophrenia patients with an F2 code according to ICD-10, and assessed the association of various factors with diabetes mellitus among these patients in a multivariable analysis.
Results During the 2-year period, there were 1899 patients hospitalized with a psychiatric disorder one or more times. Of them, a total of 770 adults with schizophrenia (285 men and 485 women) were eligible for our analysis. The standardized prevalence ratio of diabetes mellitus was 2.0 [95 % confidence interval (CI) 1.6–2.5] among men and 3.0 (95 % CI 2.5–3.6) among women in this hospital. There were no socio-environmental factors associated with diabetes mellitus among men. Among women, factors such as a 730-day hospitalization [adjusted odds ratio (OR) 3.82: 95 % confidence interval (CI) 1.52–9.64], and a medical protection/compulsory/discrimination hospitalization (adjusted OR 0.60, 95 % CI 0.36–0.99) were associated with diabetes mellitus. Compared with women living alone, those who were unmarried and lived together with someone had a significantly lower adjusted OR (0.41, 95 % CI 0.21–0.81).
Conclusions Socio-environmental factors such as length of hospitalization, type of hospitalization, and marital status and living arrangement were associated with diabetes mellitus among hospitalized women with schizophrenia.

Keywords Schizophrenia · Diabetes mellitus · Socio-environmental factors

Introduction

In Japan, the proportion of patients hospitalized with schizophrenia among those with psychiatric diseases has accounted for over 60 % [1, 2]. Although the prevalence of physical complications among hospitalized patients with schizophrenia was ~40–60 % according to the guideline on the treatment of schizophrenia, most of these patients did not receive medical treatments for those complications [3].

Diabetes mellitus is one of the most serious complications among patients with schizophrenia. Their estimated prevalence of diabetes mellitus was two to threefold higher among patients with schizophrenia compared with that of the general population [4–7], and their physical complications lead to a deterioration of their neurocognitive and psychosocial functions [8]. Among patients with schizophrenia, several factors might be associated with diabetes mellitus. For example, lifestyle factors (e.g., lower physical activity or function [9], sedentary lifestyle [7], and diets high in fat and low in fiber [10, 11]) are associated

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with high prevalence of diabetes mellitus. In addition, antipsychotic drugs (e.g., haloperidol and zotepine) administered to improve psychological symptoms were associated with a high prevalence of diabetes mellitus among schizophrenics [5, 12]. Socio-environmental factors associated with diabetes mellitus among these patients with schizophrenia were low education level and marital status [6]. However, their socio-environmental factors such as education level and social insurance have not been sufficiently investigated in Japan. Thus, an evaluation of the association between various factors and diabetes mellitus among patients with schizophrenia would contribute a helpful clue for preventing diabetes mellitus which is one of the important complications among these patients.

In this study, we aimed to epidemiologically examine various factors, such as socio-environmental factors, psychiatric symptoms, and current/past complications, associated with diabetes mellitus among patients hospitalized with schizophrenia in a single psychiatric hospital in Japan.

Methods

Study design, settings, and patients

This was a cross-sectional study from a single center. Subjects were adult patients aged ≥20 years, hospitalized with schizophrenia one or more times in a hospital which had 537 beds with departments of psychiatry and internal medicine, between January 1, 2013 and December 31, 2014, including subjects hospitalized since before December 31, 2012. From health insurance claims, we extracted schizophrenia patients with an F2 code (schizophrenia, schizotypal and delusional disorders) as listed in the International Classification of Diseases 10th revision (ICD-10) [13] as the primary and secondary diagnosis. Our study was conducted according to the Declaration of Helsinki and the Japanese ethics guidelines for epidemiological studies, and the study protocol was approved by the Ethics Committee of Osaka University Graduate School of Medicine (Number: 14185).

Data collection

In this study, information on patient characteristics was collected from health insurance claims and electronic medical records in cooperation with hospital staff. As for factors assessing the relationships between schizophrenia and diabetes mellitus [6, 14–19], we gathered the following items: age, gender, total length of hospitalization during the study period, and prescription of antidiabetics from health insurance claims, and body mass index (BMI), psychological symptoms, activities of daily living disorder (ADL disorder), current/past history of hypertension, current/past history of hyperlipidemia, prescription of antipsychotics, and socio-environmental factors such as education history, type of hospitalization, type of social insurance, marital status, and living arrangement from electronic medical records. Among patients with schizophrenia hospitalized since before December 31, 2012, we counted the total length of hospitalization from January 1, 2013, and defined 730 days as maximal length.

Study endpoint

The main outcome was the proportion of diabetes mellitus among patients hospitalized with schizophrenia. Patients with diabetes mellitus were defined as those who: (1) received medication for diabetes mellitus, (2) had a hemoglobin A1c determined by the National Glycohemoglobin Standardization Program (HbA1c NGSP) ≥6.5 %, or (3) had a fasting blood glucose level ≥126 mg/dl from laboratory tests [20, 21]. As for data on HbA1c and/or fasting blood glucose level, we used the highest value from individual laboratory data during the study period, excluding the data in the date of admission because it might not be tested on fasting state.

Statistical analysis

We conducted analyses by sex. Using data on the prevalence of patients strongly suspected to have diabetes mellitus using the National Health and Nutrition Survey (NHNS) in 2012 [22], the age-adjusted prevalence was calculated by weighting subjects in each age group from this study. Based on this prevalence, we calculated the standardized prevalence ratio (SPR) as follows:

$$\mathrm{SPR} = \frac{\sum \text{Diabetes patient number in this study}}{\sum \text{Expected number}*}$$

*Expected number = patients with schizophrenia in this study × age-adjusted prevalence of diabetes in general population.

In addition, its 95 % confidence interval (CI) was calculated using Fisher's method [23]. Chi-square test was used to compare the proportion of diabetes mellitus among the groups by characteristic. A multivariate logistic regression model was used to assess factors associated with diabetes mellitus among patients hospitalized with schizophrenia, and to calculate odds ratios (ORs) and their 95 % CIs. The following factors were incorporated into the models: age group (20–39, 40–49, 50–59, 60–69, ≥70 years old), type of hospitalization (voluntary, involuntary), total length of hospitalization (≤30, 31–364, 365–729, or 730 days), type of social insurance (public

assistance, national health insurance, government/union-managed/mutual aid associations, old–old medical insurance, other), marital status and living arrangement [single/living together, married/living together, living alone (single or married)], education (junior high school, high school, university), disability pension (yes, no), BMI (<18.5, 18.5–24.9, ≥25.0 kg/m^2), psychological symptoms [mild (patients do not have psychological symptoms at all, or has stable psychological symptoms), moderate (patients have the deficit of communication or reality testing but do not have deviancy affected from psychological symptoms), severe (patients have deviancy affected from psychological symptoms)], ADL disorder [mild (patients have independent daily life), moderate (patients have some disorder but almost independent daily life), severe (patients need to help daily life or are bedridden)], current/past history of hypertension (yes, no), current/past history of hyperlipidemia (yes, no), and antipsychotic drugs (none, typical antipsychotics, atypical antipsychotics, typical/atypical antipsychotics). All analyses were conducted with STATA version 12.0 SE software (Stata Corp LP) and the statistical significance level was set at 0.05.

Results

During the study period, 1899 patients were hospitalized with a psychiatric disorder one or more times. Of them, a total of 770 adults with schizophrenia (285 men and 485 women) were eligible for our analysis.

Table 1 shows the prevalence of diabetes mellitus among patients with schizophrenia in this study versus the general population in Japan. In this study, the number of schizophrenic patients with diabetes mellitus was 30.9 % [(218/770), 31.9 % (91/285) among men and 26.2 % (127/485) among women], whereas in the general Japanese population, age-adjusted prevalence was 15.8 % among men and 8.7 % among women. The SPR was 2.0 (95 % CI 1.6–2.5) among men and 3.0 (95 % CI 2.5–3.6) among women in this hospital, and the prevalence of diabetes mellitus was significantly higher in our study patients than in the general population. The prevalence rate ratio by age group was 6.9 in patients 20–29 years old, 17.9 in those 30–39 years old, and 5.1 in those 40–49 years old among men, and 20.9 in those 30–39 years old, and 8.3 in those 40–49 years old among women.

Table 1 Prevalence of diabetes mellitus among study subject patients with schizophrenia versus the general Japanese population

	Subjects in this study			General Japanese population[a]	Prevalence rate ratio	95 % Confidence interval	
	Schizophrenia (*N*)	Diabetes (*N*)	Prevalence (%)	Prevalence of diabetes[b] (%)			
Men							
20–29 years	24	1	4.2	0.6	6.9	0.3	34.3
30–39 years	40	10	25.0	1.4	17.9	9.1	31.8
40–49 years	58	16	27.6	5.4	5.1	3.0	8.1
50–59 years	54	18	33.3	12.2	2.7	1.7	4.2
60–69 years	67	29	43.3	20.7	2.1	1.4	3.0
≥70 years	42	17	40.5	23.2	1.7	1.1	2.7
Total	285	91	31.9	15.8[c]	2.0[d]	1.6	2.5
Women							
20–29 years	22	0	0.0	0.0	NC	NC	NC
30–39 years	61	14	23.0	1.1	20.9	11.9	34.2
40–49 years	106	15	14.2	1.7	8.3	4.8	13.4
50–59 years	95	26	27.4	6.2	4.4	2.9	6.4
60–69 years	100	35	35.0	12.6	2.8	2.0	3.8
≥70 years	101	37	36.6	16.7	2.2	1.6	3.0
Total	485	127	26.2	8.7[c]	3.0[d]	2.5	3.6

NC Not calculable

[a] From National Health and Nutrition Examination Survey

[b] Proportion of strongly suspected diabetes mellitus (National correction value)

[c] Age-adjusted prevalence weighted by subjects in each age group from this study

[d] Standarized prevalence ratio (*SPR*)

$$\mathrm{SPR} = \frac{\sum \mathrm{Diabetespatientnumberinthisstudy}}{\sum \mathrm{Expected\ number}}$$

Expected number = patients with schizophrenia in this study × age-adjusted prevalence of diabetes in general population

Table 2 shows the proportion of diabetes mellitus by characteristics in hospitalized patients with schizophrenia according to sex. Among schizophrenic men, the proportion of diabetes mellitus by total length of hospitalization was 9.8 % in ≤30 days, 34.6 % in 30–365 days, 43.9 % in 365–730 days, and 31.7 % in 730 days ($P = 0.006$), respectively. Other factors did not differ between the groups. Among schizophrenic women, the proportion of diabetes mellitus by total length of hospitalization was 13.9 % in ≤30 days, 23.8 % in 31–364 days, 34.4 % in 365–729 days, and 37.1 % in 730 days ($P = 0.003$), respectively. As for other factors, the proportion of diabetes mellitus tended to be high in patients who were unmarried and living together (32.7 %), and in those with severe psychological symptoms (46.4 %), severe ADL disorder (44.6 %), or current/past history of hypertension (42.4 %).

Factors associated with diabetes mellitus in schizophrenia men are noted in Table 3. The adjusted OR was greater in patients 60–69 years old (4.83: 95 % CI 1.48–15.76) and ≥70 years old (5.47: 95 % CI 1.34–22.32) than in those 20–39 years old. The adjusted OR among patients with a BMI ≥25 kg/m^2 was 2.52-fold greater (95 % CI 1.17–5.43) than among those with a BMI of 18.5–24.9 kg/m^2. The adjusted OR tended to be greater in patients with 30–364 days (3.05: 95 % CI 0.94–9.84) and 365–729 days (3.73: 95 % CI 0.97–14.41). However, other factors were not associated with diabetes mellitus among schizophrenic men. As for schizophrenic women (Table 4), factors such as 730-day hospitalization (adjusted OR 3.82: 95 % CI 1.52–9.64), involuntary hospitalization (adjusted OR 0.60, 95 % CI 0.36–0.99), and current/past history of hypertension (adjusted OR 2.65, 95 % CI 1.39–5.04) were associated with diabetes mellitus. Compared with women who lived alone, those who were unmarried and lived together with someone had a significantly lower adjusted OR (0.41, 95 % CI 0.21–0.81).

Discussion

From this cross-sectional single-center study, socio-environmental factors such as total length of hospitalization, type of hospitalization, and marital status/living arrangement were associated with diabetes mellitus among hospitalized women with schizophrenia. In recent preceding studies on the association between diabetes mellitus and social factors in the general population, those with lower education level had a higher proportion of diabetes mellitus [14, 15], as did single women [14] and divorced and widowed women [16]. Our study assessing the association diabetes mellitus has with socio-environmental factors among patients with schizophrenia provides new clues for preventing diabetes mellitus complications among these patients.

The SPR among both sexes was higher than that in the general population, and the value was similar to the one in previous reports [5–7, 24]. In particular, the proportion of diabetes mellitus among younger adults with schizophrenia was higher than that in the general population, and our results confirmed those findings from previous reports [5–7, 12, 24]. A previous study suggested that patients with schizophrenia were vulnerable to dysfunctional glucose metabolism at earlier ages [25], which might explain this result and also suggests the importance of diabetes mellitus intervention and prevention for them.

This study underscored that schizophrenic women with a long-term hospitalization had a higher OR for diabetes mellitus compared with those with a short-term hospitalization. Factors associated with diabetes mellitus among patients with schizophrenia were reportedly sedentary lifestyle [7] and a shorter distance achieved in a 6-min walk test [9]. Hospitalization could cause a lower amount of activity and be associated with diabetes mellitus in a lengthened hospitalization. Indeed, the Global Assessment of Functioning (GAF) score, an index of social function, was low in schizophrenia patients with long-term hospitalization [17]. On the other hand, the aim of hospitalization in psychiatric hospitals is to improve psychiatric symptoms. It is different from the hospitalization for diabetes mellitus such as the improvement of diabetic symptoms or educational hospitalization for blood glucose control. Indeed, it was reported in Japan that 62.5 % of inpatient with schizophrenia did not go out at all, 55.0 % did not exercise at all, 27.9 % drank soft drink every day, and 17.0 % ate snacks too much [26]. Considering this result, patients with long-term hospitalization have possibilities to eat between-meal snacks and not to exercise. In addition, the results of long-term hospitalization among schizophrenic men tended to be similar to that among women. Thus, medical stuff could not sufficiently manage in-hospital lifestyles that might affect the development of diabetes mellitus among these patients with both men and women.

The OR for diabetes mellitus among schizophrenic women who had an involuntary hospitalization, such as a medical protection/compulsory/discrimination hospitalization, was lower than among those with a voluntary hospitalization. Both diet therapy and exercise therapy are recommended for the treatment of diabetes mellitus, and it is important to control blood glucose levels [27]. For example, previous research showed that metabolic symptoms among prisoners with diabetes mellitus were improved because of the regular life in a prison [28], and controlling lifestyle leads to improving symptoms of diabetes mellitus. In involuntary hospitalizations, medical

Table 2 Proportion of diabetes mellitus by characteristics in patients hospitalized with schizophrenia according to gender

Factor	Category	Men			Women		
		Subject (*N*)	Diabetes, *n* (%)	*P* value	Subjects (*N*)	Diabetes, *n* (%)	*P* value
Age group	20–39 years	64	11 (17.2)	0.015	83	14 (16.9)	<0.001
	40–49 years	58	16 (27.6)		106	15 (14.2)	
	50–59 years	54	18 (33.3)		95	26 (27.4)	
	60–69 years	67	29 (43.3)		100	35 (35.0)	
	≥70 years	42	17 (40.5)		101	37 (36.6)	
BMI	<18.5 kg/m^2	38	15 (39.5)	0.078	97	28 (28.9)	0.776
	18.5–24.9 kg/m^2	173	47 (27.2)		255	62 (24.3)	
	≥25.0 kg/m^2	71	29 (40.8)		127	35 (27.6)	
	Unknown	3	0 (0.0)		6	2 (33.3)	
Education	Junior high school	98	30 (30.6)	0.980	150	45 (30.0)	0.269
	High school	105	35 (33.3)		195	53 (27.2)	
	University	73	23 (31.5)		122	24 (19.7)	
	Unknown	9	3 (33.3)		18	5 (27.8)	
Type of social insurance	Public assistance	123	39 (31.7)	0.262	164	47 (28.7)	0.664
	National health insurance	117	43 (36.8)		213	53 (24.9)	
	Government/union-managed/ mutual aid associations	25	4 (16.0)		64	14 (21.9)	
	Old–old medical insurance	18	5 (27.8)		44	13 (29.5)	
	Others	2	0 (0.0)		0	0 (0.0)	
Marital status & Living arrangement	Living alone (unmarried or married)	86	21 (24.4)	0.257	155	24 (15.5)	0.003
	Unmarried/living together	26	8 (30.8)		98	32 (32.7)	
	Married/living together	167	59 (35.3)		222	68 (30.6)	
	Unknown	6	3 (50.0)		10	3 (30.0)	
Type of hospitalization	Voluntary	139	38 (27.3)	0.105	227	66 (29.1)	0.175
	Involuntary	146	53 (36.3)		258	61 (23.6)	
Total length of hospitalization	≤30 days	41	4 (9.8)	0.006	72	10 (13.9)	0.003
	30–364 days	162	56 (34.6)		260	62 (23.8)	
	365–729 days	41	18 (43.9)		64	22 (34.4)	
	730 days	41	13 (31.7)		89	33 (37.1)	
Disability pension	No	159	49 (30.8)	0.651	291	81 (27.8)	0.312
	Yes	126	42 (33.3)		194	46 (23.7)	
Psychological symptom	Mild	116	36 (31.0)	0.366	187	42 (22.5)	0.053
	Moderate	147	45 (30.6)		269	72 (26.8)	
	Severe	22	10 (45.5)		28	13 (46.4)	
	Unknown	0	0 (0.0)		1	0 (0.0)	
ADL disorder	Mild	194	61 (31.4)	0.291	319	75 (23.5)	0.010
	Moderate	53	14 (26.4)		84	21 (25.0)	
	Severe	25	12 (48.0)		56	25 (44.6)	
	Unknown	13	4 (30.8)		26	6 (23.1)	
Medical history of hyperlipidemia	No	223	68 (30.5)	0.324	370	93 (25.1)	0.345
	Yes	62	23 (37.1)		115	34 (29.6)	
Medical history of hypertension	No	239	71 (29.7)	0.067	400	91 (22.8)	<0.001
	Yes	46	20 (43.5)		85	36 (42.4)	
Antipsychotic drug	None	22	8 (36.4)	0.360	37	10 (27.0)	0.305
	Typical antipsychotics	31	10 (32.3)		46	17 (37.0)	
	Atypical antipsychotics	149	41 (27.5)		269	64 (23.8)	
	Typical/atypical antipsychotics	83	32 (38.6)		133	36 (27.1)	

ADL activities of daily living, *BMI* body mass index

Table 3 Factors associated with diabetes mellitus in men hospitalized with schizophrenia

	Univariate				Multivariate			
	OR	95 % CI		*P* value	OR	95 % CI		*P* value
Age group								
20–39 years	Reference				Reference			
40–49 years	1.84	0.77	4.37	0.170	2.34	0.81	6.75	0.115
50–59 years	2.41	1.02	5.70	0.045	2.76	0.92	8.26	0.070
60–69 years	3.68	1.64	8.26	0.002	4.83	1.48	15.76	0.009
≥70 years	3.28	1.34	8.02	0.009	5.47	1.34	22.32	0.018
BMI								
<18.5 kg/m^2	1.75	0.84	3.63	0.134	1.11	0.43	2.86	0.821
18.5–24.9 kg/m^2	Reference				Reference			
≥25.0 kg/m^2	1.85	1.04	3.31	0.037	2.52	1.17	5.43	0.018
Education								
Junior high school	Reference				Reference			
High school	1.13	0.63	2.05	0.678	1.82	0.85	3.92	0.125
University	1.04	0.54	2.01	0.900	1.72	0.73	4.05	0.212
Type of social insurance								
Public assistance	Reference				Reference			
National health insurance	1.25	0.73	2.14	0.410	1.37	0.62	3.02	0.433
Government/union-managed/mutual aid associations	0.41	0.13	1.28	0.124	0.86	0.22	3.32	0.821
Old–old medical insurance	0.83	0.28	2.49	0.737	0.59	0.14	2.41	0.462
Others	NC	NC	NC	NC	NC	NC	NC	NC
Marital status & Living arrangement								
Living alone (unmarried or married)	Reference				Reference			
Unmarried/living together	0.59	0.33	1.06	0.079	0.51	0.22	1.16	0.109
Married/living together	0.81	0.33	1.98	0.650	0.59	0.19	1.90	0.379
Type of hospitalization								
Voluntary	Reference				Reference			
Involuntary	1.51	0.92	2.50	0.106	1.47	0.77	2.80	0.248
Total length of hospitalization								
≤30 days	Reference				Reference			
30–364 days	4.89	1.66	14.41	0.004	3.05	0.94	9.84	0.062
365–729 days	7.24	2.18	24.08	0.001	3.73	0.97	14.41	0.056
730 days	4.29	1.26	14.60	0.020	1.98	0.50	7.81	0.327
Disability pension								
No	Reference				Reference			
Yes	1.12	0.68	1.85	0.651	1.12	0.58	2.19	0.730
Psychological symptom								
Mild	Reference				Reference			
Moderate	0.98	0.58	1.66	0.941	0.98	0.49	1.93	0.944
Severe	1.85	0.73	4.68	0.193	2.07	0.64	6.72	0.225
ADL disorder								
Mild	Reference				Reference			
Moderate	0.78	0.40	1.55	0.481	0.53	0.23	1.22	0.135
Severe	2.01	0.87	4.67	0.103	1.18	0.41	3.45	0.756
Medical history of hyperlipidemia								
No	Reference				Reference			
Yes	1.34	0.75	2.42	0.325	1.09	0.52	2.28	0.827

Table 3 continued

	Univariate				Multivariate			
	OR	95 % CI		*P* value	OR	95 % CI		*P* value
Medical history of hypertension								
No	Reference				Reference			
Yes	1.82	0.95	3.47	0.069	0.87	0.38	1.99	0.742
Antipsychotic drug								
None	Reference				Reference			
Typical antipsychotics	0.83	0.26	2.63	0.756	0.71	0.17	2.91	0.635
Atypical antipsychotics	0.66	0.26	1.70	0.394	0.75	0.22	2.48	0.633
Typical/atypical antipsychotics	1.10	0.41	2.91	0.851	0.90	0.25	3.29	0.872

ADL activities of daily living, *BMI* body mass index, *OR* odds ratio, *CI* confidence interval, *NC* not calculable

Table 4 Factors associated with diabetes mellitus in women hospitalized with schizophrenia

	Univariate				Multivariate			
	OR	95 % CI		*P* value	OR	95 % CI		*P* value
Age group								
20–39 years	Reference				Reference			
40–49 years	0.81	0.37	1.79	0.607	0.58	0.23	1.45	0.248
50–59 years	1.86	0.89	3.86	0.097	1.05	0.44	2.51	0.907
60–69 years	2.65	1.31	5.38	0.007	1.09	0.43	2.75	0.860
≥70 years	2.85	1.41	5.75	0.003	1.30	0.44	3.78	0.636
BMI								
<18.5 kg/m^2	1.26	0.75	2.13	0.382	1.08	0.55	2.12	0.828
18.5–24.9 kg/m^2	Reference				Reference			
≥25.0 kg/m^2	1.18	0.73	1.92	0.493	1.66	0.89	3.10	0.113
Education								
Junior high school	Reference				Reference			
High school	0.87	0.54	1.39	0.565	1.41	0.78	2.55	0.258
University	0.57	0.32	1.01	0.053	1.02	0.50	2.07	0.960
Type of social insurance								
Public assistance	Reference				Reference			
National health insurance	0.82	0.52	1.31	0.411	1.30	0.69	2.43	0.420
Government/union-managed/mutual aid associations	0.70	0.35	1.38	0.300	0.86	0.33	2.24	0.761
Old–old medical insurance	1.04	0.50	2.17	0.908	1.02	0.37	2.82	0.963
Others	NC	NC	NC	NC	NC	NC	NC	NC
Marital status & Living arrangement								
Living alone (unmarried or married)	Reference				Reference			
Unmarried/living together	0.41	0.25	0.70	0.001	0.41	0.21	0.81	0.011
Married/living together	1.10	0.66	1.83	0.719	1.58	0.79	3.17	0.195
Type of hospitalization								
Voluntary	Reference				Reference			
Involuntary	0.76	0.50	1.13	0.175	0.60	0.36	0.99	0.048
Total length of hospitalization								
≤30 days	Reference				Reference			
30–364 days	1.94	0.94	4.01	0.073	1.42	0.64	3.17	0.393
365–729 days	3.25	1.40	7.55	0.006	2.03	0.77	5.37	0.153
730 days	3.65	1.65	8.09	0.001	3.82	1.52	9.64	0.004

Table 4 continued

	Univariate				Multivariate			
	OR	95 % CI		*P* value	OR	95 % CI		*P* value
Disability pension								
No	Reference				Reference			
Yes	0.81	0.53	1.22	0.312	0.75	0.43	1.30	0.307
Psychological symptom								
Mild	Reference				Reference			
Moderate	1.26	0.82	1.95	0.297	1.26	0.75	2.13	0.381
Severe	2.99	1.32	6.78	0.009	2.28	0.80	6.51	0.125
ADL disorder								
Mild	Reference				Reference			
Moderate	1.08	0.62	1.89	0.776	0.79	0.41	1.51	0.468
Severe	2.62	1.46	4.72	0.001	1.90	0.87	4.17	0.107
Medical history of hyperlipidemia								
No	Reference				Reference			
Yes	1.25	0.79	1.99	0.346	0.90	0.51	1.58	0.708
Medical history of hypertension								
No	Reference				Reference			
Yes	2.49	1.53	4.07	<0.001	2.65	1.39	5.04	0.003
Antipsychotic drug								
None	Reference				Reference			
Typical antipsychotics	1.58	0.62	4.05	0.339	1.72	0.56	5.28	0.347
Atypical antipsychotics	0.84	0.39	1.84	0.667	1.14	0.44	2.99	0.787
Typical/atypical antipsychotics	1.00	0.44	2.28	0.996	1.10	0.39	3.10	0.852

ADL activities of daily living, *BMI* body mass index, *OR* odds ratio, *CI* confidence interval, *NC* not calculable

staff manages lifestyles such as dietary and sleeping duration among patients with schizophrenia, which might result in their lower proportion of diabetes.

Compared with schizophrenic women who lived alone, those who were unmarried and lived together with someone had a significantly lower OR for diabetes mellitus, but those who were married and living together did not. The association of diabetes mellitus with living arrangement and marital status in preceding studies is still under debate. The proportion of diabetes mellitus among married schizophrenic patients was significantly lower than among unmarried ones [6]. On the other hand, the proportion of diabetes mellitus among women in general living together with someone was significantly lower than that of those living alone [29], and this result was similar to ours. Generally, support from a partner might explain the lower proportion of diabetes mellitus among married persons [30, 31]. Although our findings from this study would suggest that support for schizophrenic women by medical staff or family members, but not by husbands, was important, the association between diabetes mellitus and living arrangement or marital status among patients with schizophrenia needs to be confirmed by other cohorts.

In this study, the OR for diabetes mellitus among both sexes with schizophrenia did not differ because of education level. In other studies, the proportion of diabetes mellitus among the general population with a lower education level was higher than among those with higher education level [14, 15, 18, 19], but this result was inconsistent with ours. Those with a higher education level had better physical and social environments [14] and could better access and understand information on healthcare from specialists [32]. Thus, higher education level could be associated with good environments, but we did not detect an association between education level and diabetes mellitus among patients with schizophrenia in this study.

The OR for diabetes mellitus among schizophrenic women with hypertension was higher than among those without hypertension. Hypertension is part of the diabetes mellitus screening criteria in the guideline on the treatment of diabetes mellitus [27], and is one of the standard risk factors of diabetes mellitus among patients with psychiatric disorders in the guideline on the treatment of schizophrenia [3]. In addition, the OR for diabetes mellitus among schizophrenic men with a BMI $\geq$25 kg/m^2 was higher than among those with a BMI of 18.5–24.9 kg/m^2. These results

reinforce the importance of making lifestyle improvements for reducing the number of diabetes mellitus patients with or without schizophrenia.

Among male patients with schizophrenia, there were no social-environment factors associated with diabetes mellitus. However, for example, the ORs of the involuntary hospitalization were 1.47 in men and 0.60 in women compared with the voluntary hospitalization and there was a gender difference. In preceding studies among general population, unmarried women had lower OR of diabetes mellitus compared with married women [14], and those who had lower education had higher OR of diabetes mellitus in both sexes but the OR was greater in women than in men [33]. Therefore, it may be that men and women in different social economic status group have different health beliefs and lifestyle factors that may be associated with the risk of type 2 diabetes [33, 34]. Although the definitive reasons for these sex-related differences remain unclear in the literatures including ours [33, 35], further efforts would be needed to investigate this relationship.

Limitations

Our observations have several inherent limitations. First, this was a cross-sectional study from a single center, and there was the potential for selection bias. There have been many cross-sectional studies including ours investigating the risk factors associated with diabetes mellitus among schizophrenic patients, but a long-term follow-up cohort study assessing the risk factors among them is needed. Moreover, although the association between diabetes mellitus and socio-environmental factors among men with schizophrenia was unclear in this study, the association should also be assessed by other studies. Second, this study could not distinguish between new-onset diabetes mellitus and previous diabetes mellitus. Third, this study did not obtain information on the known risk factors for diabetes mellitus such as dietary pattern, exercise, smoking, alcohol drinking, and family history of diabetes; therefore, we could not adjust these variables in our analyses [36]. Furthermore, there might be unknown confounders affecting the association between diabetes mellitus and schizophrenia. Fourth, we would estimate greater number of patients with diabetes mellitus in this study than in the NHNS, because the prevalence of diabetes mellitus in this study was the period prevalence for 2 years, different from the point prevalence in the NHNS. Therefore, our estimation of the SPR and prevalence rate ratio by age group might be higher than expected. Fifth, the sample size in this study was small, and our results cannot be generalized to schizophrenia patients in the greater population. For example, schizophrenic men with a long-term hospitalization tended to have higher ORs for diabetes mellitus compared with those with a short-term hospitalization. Therefore, our results should be confirmed by further large-scale cohorts.

Conclusions

In this cross-sectional study from a single center, the prevalence rate ratio among patients with schizophrenia was higher than among general population in both sexes, especially among younger adults. The socio-environmental factors such as length of hospitalization, type of hospitalization, and marital status/living arrangement were associated with diabetes mellitus among hospitalized women with schizophrenia, but not among men with schizophrenia. Therefore, women with schizophrenia would need the prevention or intervention for diabetes mellitus from various healthcare practitioners such as public health nurses, nurses, and psychiatric social workers cooperatively based on these factors, especially when younger adults have schizophrenia. In addition, it is important to confirm socio-environmental risk factors for diabetes mellitus among patients with schizophrenia by prospective studies.

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Conflicts of interest We have no conflicts of interest to declare.

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